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ORIGIN OF IGNEOUS ROCKS.

Igneous Rocks and their Origin. By Prof. R. A. Daly. Pp. xxii+563. (London: Hill Publishing Co., Ltd.; New York: McGraw-Hill Book Co., Inc., 1914.) Price 17*s.* net.

PROF. DALY is a man of ideas. A few facts observed in the field suggest to him a hypothesis which he then proceeds to test by searching for other facts which must exist if the hypothesis be of any value for scientific purposes. He is perhaps most widely known as the author who, more than any other, has developed the theory of "magmatic stoping." Large masses of plutonic rock—such, for example, as the granites of Devon and Cornwall—can be proved by field evidence to fill spaces that must formerly have been occupied by other rocks. In the case referred to the displaced rocks consisted largely of folded sediments. What has become of them? According to the theory in question, the roof of the magmatic chamber has been shattered, and the detached fragments have in general sunk in the rising plutonic magma. This theory is explained and illustrated in the present volume, and much use is made of one of its probable consequences—namely, the development of secondary magmas by "syntexis"; or, in other words, by the solution in the rising magma of the masses detached from the walls and roof of the magma chamber. This action is believed to account directly or indirectly for many varieties of igneous rock.

But the theory of magmatic stoping is only a subsidiary feature of the work. Its main object is to explain the known facts of igneous geology by a few general assumptions as to the composition, structure, and physical condition of the planet, and whatever view is taken as to the validity of the assumptions, there can be no doubt that in working out their consequences the author has produced a most interesting work, full of information on the present-day aspects of igneous geology, and eminently calculated to stimulate thought.

The book is divided into three parts. The first deals with the composition and mode of occurrence of igneous rocks, the relative abundance of the different types at the surface of the earth, and the phenomena of active volcanoes. Rosenbusch's classification is adopted with slight modifications. The classification based on the "norm" is discarded as being useless for the object which the author has in view. The second part deals with abyssal injection, magmatic stoping, assimilation, and differentiation, the mechanism of volcanic vents, and concludes with a statement of what the author terms an *eclectic* theory of igneous rocks. By the term *eclectic* he means to imply that in framing the theory he has selected and appropriated whatever seemed to him best in the earlier theories relating to the same subject. The third part is devoted to applying the general theory to igneous rocks, which, for this purpose, are divided into seven great groups or clans: the gabbro-clan, the granite-clan, the diorite-clan, the granodiorite-clan, the syenite-clan, the alkaline-clans, and the peridotite-clan (including magmatic ores).

The eclectic theory may be briefly summarised as follows:—The earth, regarded as a planet, is roughly stratified according to density, but the three outer shells are alone involved in the production of the igneous phenomena with which geologists have to deal. The outer shell is composed of sediments, with an admixture of volcanic material, and is discontinuous. The second shell, represented by the Canadian and Fennoscandian "shields," approximates to granite in composition. It is probably continuous under continental areas, but may not be present under all the oceanic areas. These two shells collectively form the "crust" of the earth. Beneath them is a third shell or substratum of basaltic composition which alone, "since an early pre-Cambrian period (typified in the Keewatin) has been not enough for spontaneous eruption." It may be discontinuous, but, if so, parts of it underlie both oceanic and continental areas. Abyssal injection implies the rise of the material of the substratum in magmatic wedges which are superheated at the higher levels and therefore capable of dissolving the rocks of the crust to a variable but large extent. Both the primary basaltic magma and each of its solutions with crust-rocks are subject in certain conditions to magmatic differentiation, this giving rise to various magmas by the freezing of which the different types of igneous rock have been produced. A few illustrations of the way in which the author applies the theory will now be given.

The composition of the primary basaltic magma is regarded as that of a basalt containing only a moderate amount of olivine. From such a magma basalts and gabbros rich and poor in olivine may be derived by gravitative differentiation to which the author attaches great importance. Peridotites and anorthosites may be regarded as the extreme phases of the differentiation of the primary magma. Quartz-basalts and related rocks which are now known to be widely distributed in continental areas, though apparently absent from oceanic areas, probably owe their origin to the

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slight acidification of the primary magma through the solution of siliceous crust-rocks.

In discussing the origin of the rocks forming the granitic clan, the author describes at considerable length cases in which granites are found in association with thick intrusive sheets or sills of basalt or gabbro. Thus the Purcell sills of British Columbia, which vary in thickness from 100 ft. or less to about 1500 ft., are intrusive in thick felspathic and micaceous quartzites of Cambrian or earlier date. In several instances the top of a sheet consists "of a true biotite-granite (rarely hornblendic) passing downward into hornblendic gabbro." Inclusions of quartzite surrounded by syntectic material occur in the gabbro, and the author maintains that the granite of these sills is the gravitative differentiate of a quartzite-gabbro syntectic. The post-Cambrian batholithic granites are supposed to have been formed in a somewhat similar way. They are regarded as differentiates of crust-material dissolved in large abyssal wedges injected from the basaltic substratum. The author, however, hesitates to extend his theory to all the large pre-Cambrian batholiths, and suggests that some of these may be re-fused portions of a primitive crust of granitic composition, the necessary heat having been supplied by radio-activity. Although he refers more than once to radio-activity, this is the only case in which he appears to regard it with any degree of favour as a source of the thermal energy manifested in igneous action.

The origin of each of the other clans is discussed at length, and the chapter dealing with alkaline rocks which are regarded as differentiates of syntectics of primary basalt and carbonates is of special interest. The concluding chapter deals with the application of the general theory to the igneous phenomena of the North American Cordillera.

The book represents an interesting attempt to solve a problem of great complexity with the aid of our present knowledge, which is probably quite insufficient for the purpose.

INTRODUCTIONS TO NATURAL SCIENCE.

(1) *The Realm of Nature. An Outline of Physiography.* By Dr. H. R. Mill. Second Edition, largely re-written. Pp. xii + 404. (London: John Murray, 1913.) Price 5*s.*

(2) *Introduction to Biology. An Elementary Text-book and Laboratory Guide.* By Prof. M. A. Bigelow and Anna N. Bigelow. Pp. ix + 424. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1913.) Price 6*s.*

(3) *Botany.* By Prof. E. Brucker. Pp. xv + 185. (London: Constable and Co., Ltd., 1913.) Price 2*s.* net.

(4) *A First Book of Nature Study.* By E. Stenhouse. Pp. 148. (London: Macmillan and Co., Ltd., 1913.) Price 1*s.* 6*d.*

(5) *Weeds. Simple Lessons for Children.* By R. L. Praeger. With illustrations by S. Rosamond Praeger and R. J. Welch. Pp. x + 108. (Cambridge University Press, 1913.) Price 1*s.* 6*d.* net.

(6) *Notes on the Natural History of Common British Animals and some of their Foreign Relations. Vertebrates.* By Kate M. Hall. Pp. xii + 289. (London: Adlard and Son, 1913.) Price 3*s.* 6*d.* net.

(1) SINCE 1891 Dr. Mill's "Realm of Nature" has been well known as one of the very best introductions to the study of the physical aspects of the world we live in. Along with a few other books, such as Huxley's "Physiography," it has occupied the first rank among text-books, and that place this new edition will retain. The reasons for this are to be found in the author's quite remarkable clearness of head and style (which everyone who has heard him lecture has admired and envied), in his competence to deal with the many sides of the synoptic science of physiography, and also, we think, in the success with which he has made his facts illustrate principles. The book deals with the earth, the atmosphere, climate, weather, the ocean, the action of water on the land, the record of the rocks, the continents, the distribution of organisms, and man in nature. It has been thoroughly revised and brought up to date, but we are relieved to find that it remains in essence as we have known it for nearly a quarter of a century—with the same grip and terseness, the same absence of loose ends and dark corners—along certain lines one of the most educative books we have read. Though in a new dress it is an old friend, and we may be allowed with heartiness to wish it and its author well.

(2) The introduction to biology proposed by Prof. Maurice A. Bigelow and Anna N. Bigelow is one which the authors have tested and found serviceable. It is an introduction to biological facts and ideas, and it is distinctive in selecting those facts and ideas which have a direct bearing on daily life. Thus we find much attention paid to the structure and functions of the human body, the biology of personal hygiene, organisms that affect human health, the economic relations of organisms, the reproduction of organisms, and so on. To our thinking, this is a partial introduction

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